Armed Forces College of Medicine
(AFCM)

Histology Department

Platelets

(Thrombocytes) & Thrombopoiesis

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Intended Learning Objectives (ILOs)

By the end of this lecture the student should be able to:

- **Correlate the structure of platelets to their function.**
- **Interpret the changes in the platelets in the different diseases**
- **Describe the stages of thrombopoiesis.**

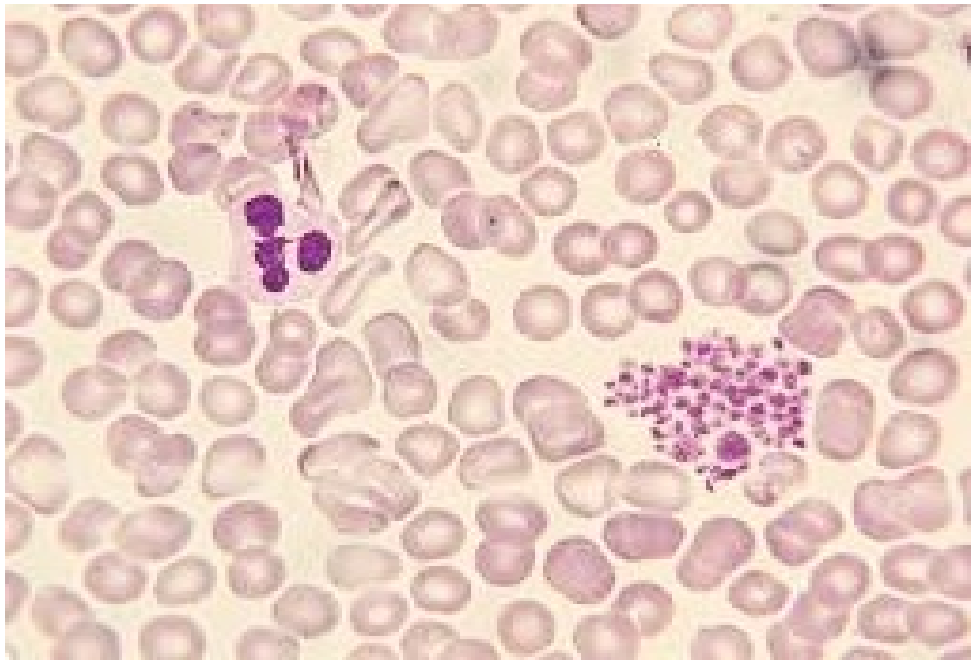
Lecture Plan

1. Part 1 (3 min): Introduction to platelets
2. Part 2 (40 min): platelet structure and function and the stages of thrombopoiesis.
3. Part 3 (3 min): Summary
4. Lecture Quiz (4 min)

Platelets (Thrombocytes)

- **They are very small non-nucleated, membrane-bound cell fragments**

- **Origin: Megakaryocytes in B.M**
- **No. : 200,000-400,000/mm3 of blood**
- **Size : 2-4 µm in diameter**
- **Life span: about 7-10 days.**
- **Shape: L.M. & E.M.**
- **Function:**



Platelets (Thrombocytes)

L.M: (in Stained-Blood Film)

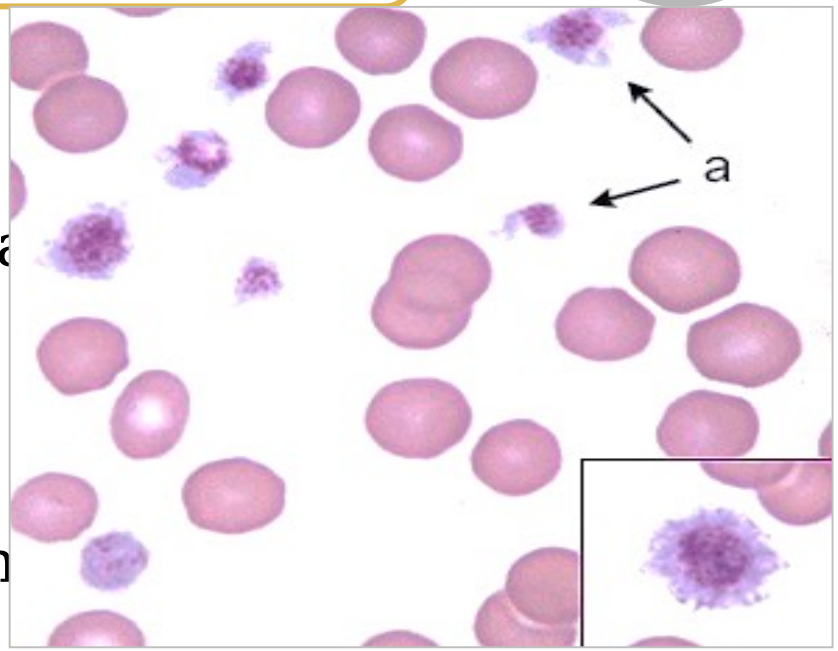
Thin non-nucleated **biconvex** discs, often appea

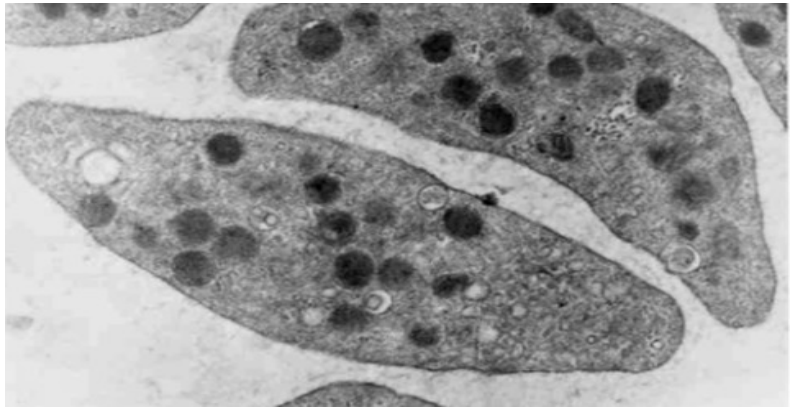
Have 2 zones;

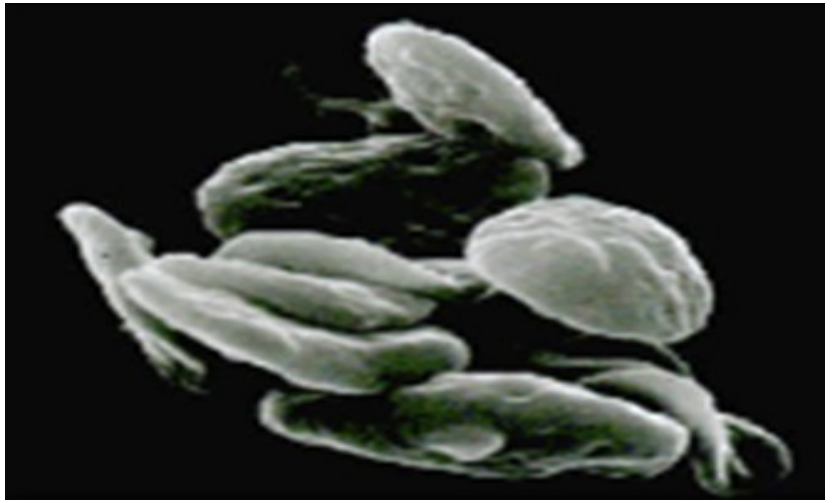
the hyalomere: thin clear peripheral z

the granulomere: a dark central gra on

= (rich in granu



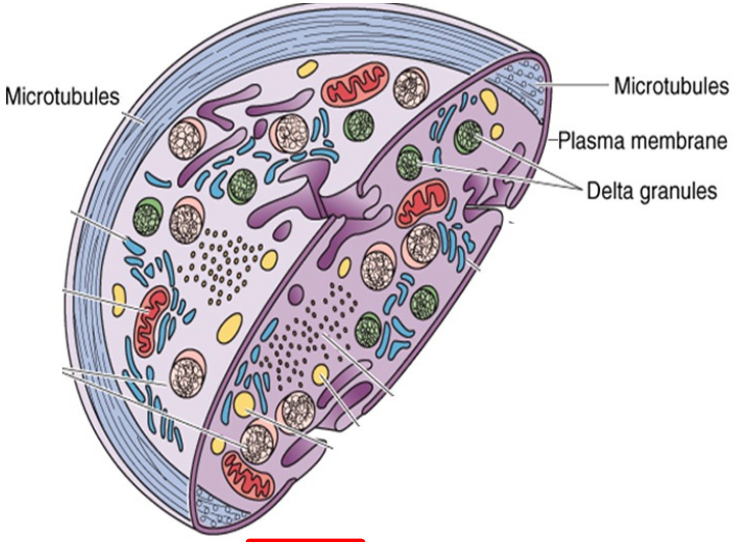




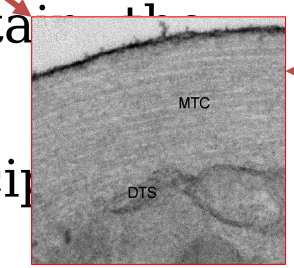
Platelets (Thrombocytes)

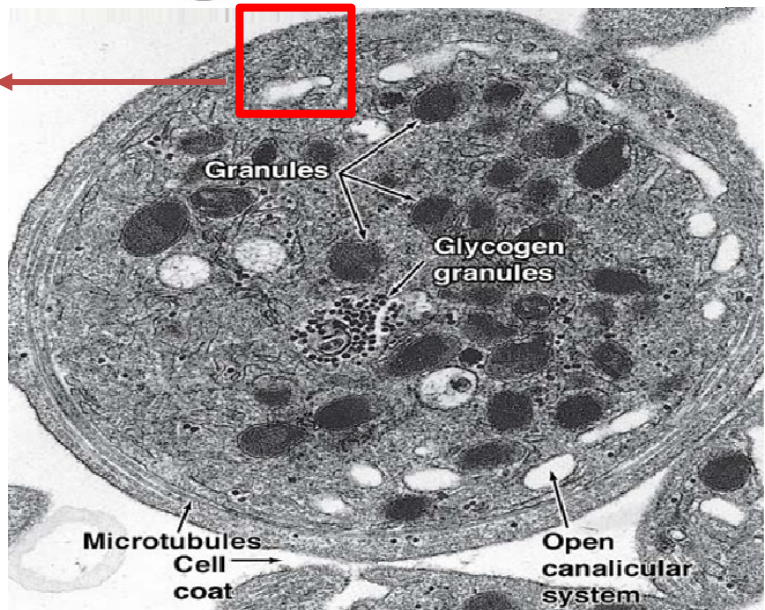
E.M: (Ultrastructure)

- **A plasma membrane** covered by a **cell coat (glycocalyx)** for platelets **adhesion and activation** during blood coagulation.



- **The hyalomere** contains:
  - Marginal bundle of
    1. **Microtubules** arranged parallel to each other & to the plasma membrane to maintain the shape of platelets.
    2. **Actin and myosin filaments** that participate in clot retraction and release action.





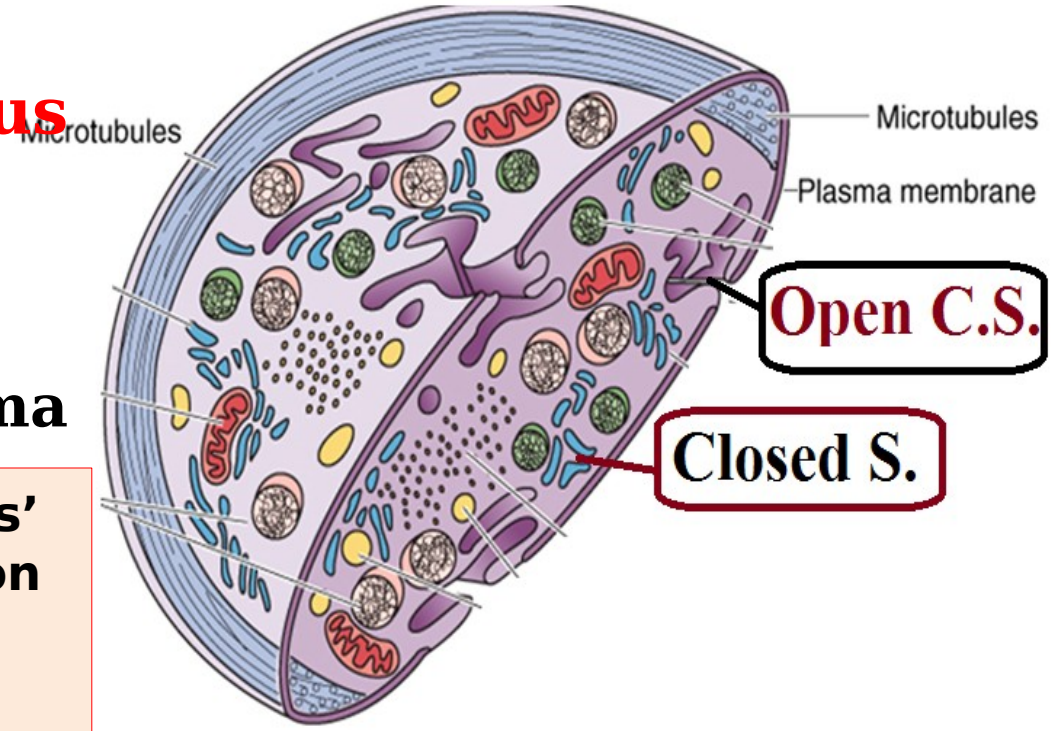
  - 2 System of membrane channels: ….

- **The granulomere**

Platelets (Thrombocytes)

E.M: (Ultrastructure)

"2 Systems of membranous channels"



1. Open canalicular system:

Tubular invaginations of **the plasma**

To: Facilitate the rapid exocytosis of granules' contents of the platelets (degranulation) upon platelets activation (exposure to sub-endothelium collagen).

2. Closed tubular system:

To: store Ca^{2+} ions .

Platelets (Thrombocytes)

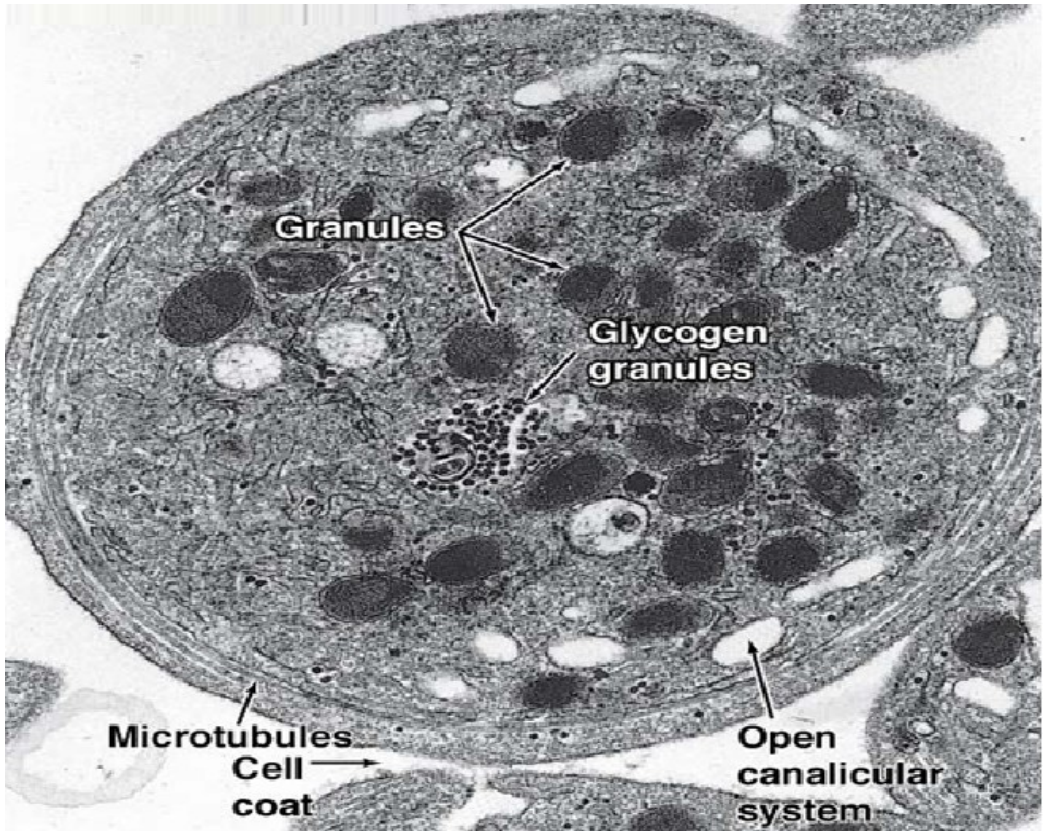
E.M: (Ultrastructure)

- **The granulomere** contains:

  Glycogen

  Few mitochondria

  3 types of granules: (α, δ, λ



3 Types of Platelets Granules

Alpha (α)

Delta (δ)

Lambda (λ) granules

= Lysosomes

Help "**clot resorption**" during late stages of vessel repair

coagulation &

Vasoconstriction

Platelets (Thrombocytes)

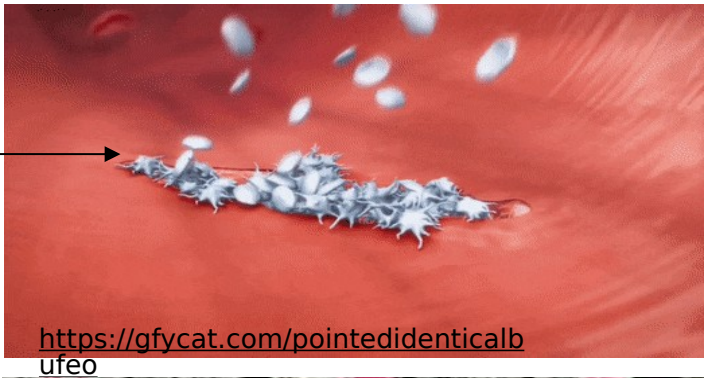
Function:

Platelets (Thrombocytes)

Function: **Control blood loss (hemorrhage) and promote thrombus formation as follows:**

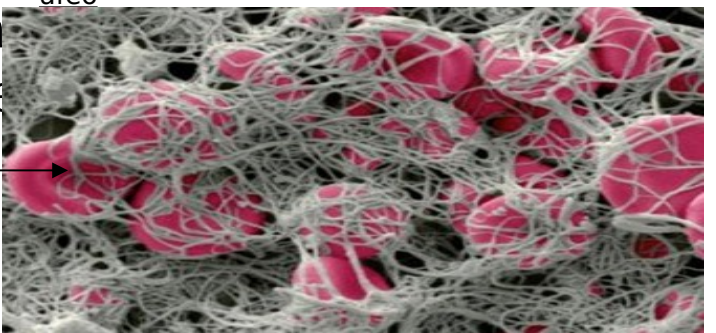
- **.Primary aggregation (Adhesion):**
  Endothelium injury allows sub-endothelial collagen exposure
  ….. the platelet glycocalyx adhere tothe vascular wall
  ….. **platelet plug** formation.

- **.Activation of platelets:** a shape change and degranulation occurs.
- **.Secondary aggregation:**
  Platelets in the plug release **ADP**… more platelet aggregation



.Blood coagulation:

Platelet factor 4 stimulates activation of fibrinogen into fibrin
3D network of fibers trapping RBCs, WBCs and more plate
"Blood clot"="Thrombus"



- **.Clot retraction:** by platelets' actin & myosin

Clot removal:

The vessel wall is restored by new tissue, so the clot is then removed,

mainly by the proteolytic enzyme **plasmin** and the

enzymes released
from platelet lambda granules .

Clinical Application

Platelet Deficiency

Thrombocytopenia:

It is a **decrease** in the number of platelets < 150,000/ mm^2.

occurs in **thrombocytopenic purpura** where **bleeding time is increased**

https://www.alamy.com/a-photograph-showing-idiopathic-thrombocytopenic-purpura-itp-image4970404.html

http://ww3.onvacations.co/red-dots-on-my-inner-lip/

Thrombopoiesis

= The process by which platelets are formed

Thrombopoiesis

Stem cells
(BM)

Progenitor cells
(CFU)

Precursor cells
(=Blasts)

Mature cells
(=Functioning cell)

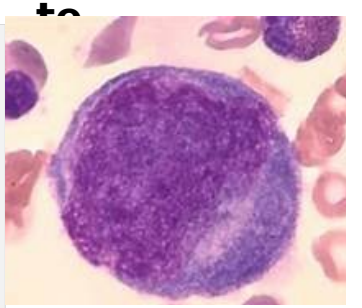
Hemopoietic stem cells (in BM)

Common Myeloid Progenitor (CFU-EGMM)

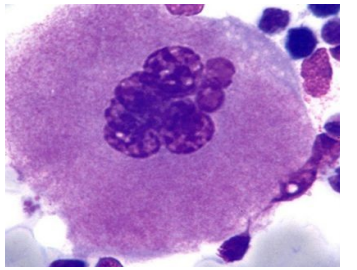
Erythrocyte
Granulocytes
Monocyte
Megakaryocyte

Megakaryoblasts

Endomitosis without cell division, so nucleus becomes larger and polyploid.

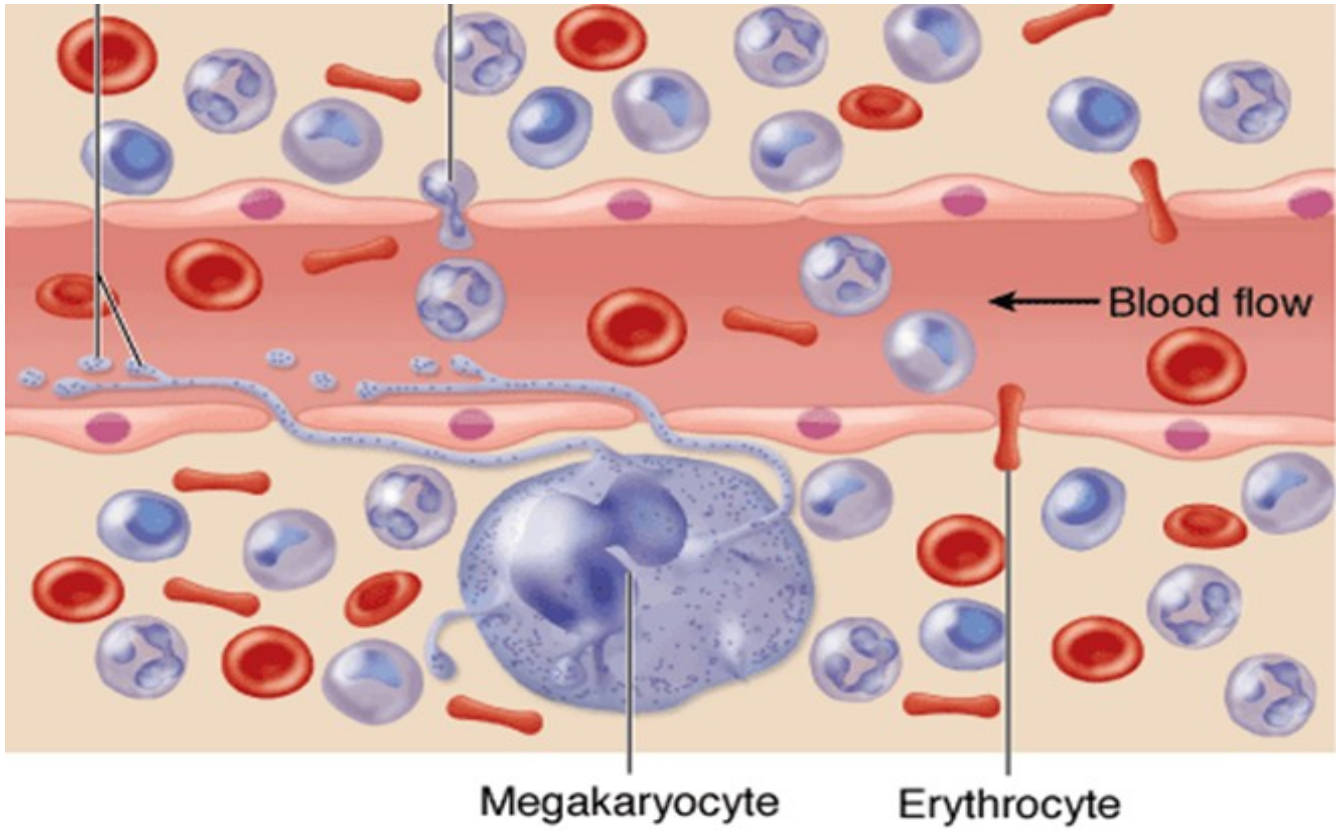


Megakaryocytes



Platelets

Megakaryocyte



https://www.youtube.com/watch?v=sRYvre9UPBI

Megakaryocyte

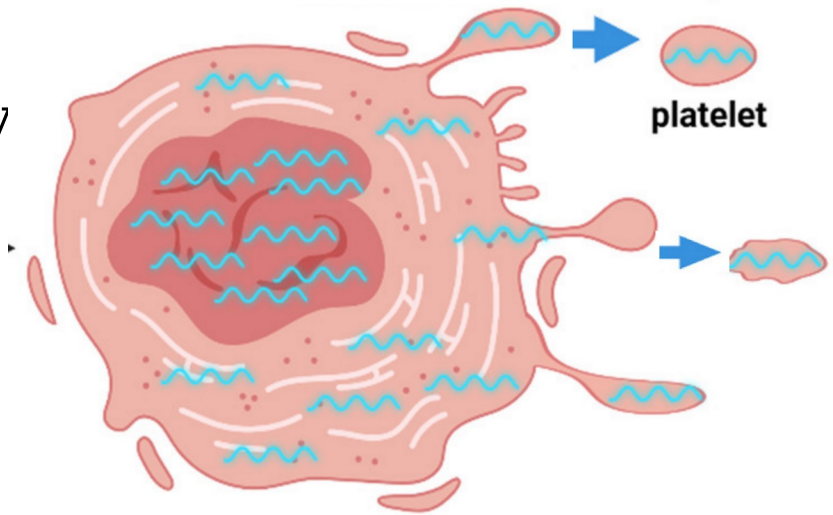
Site:

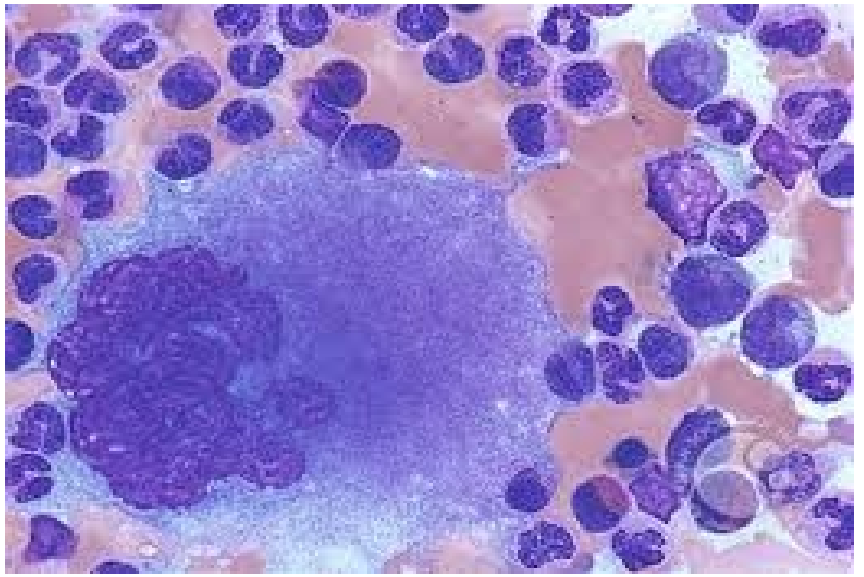
- **Bone marrow,** typically **near sinusoidal capillaries.**

L.M:

- **A giant cell** (about 150 µm).
- **Homogenous basophilic cytoplasm.**
- Has large **irregular lobulated (polypoid) nucleus** due to **endomitosis**

div .osomal





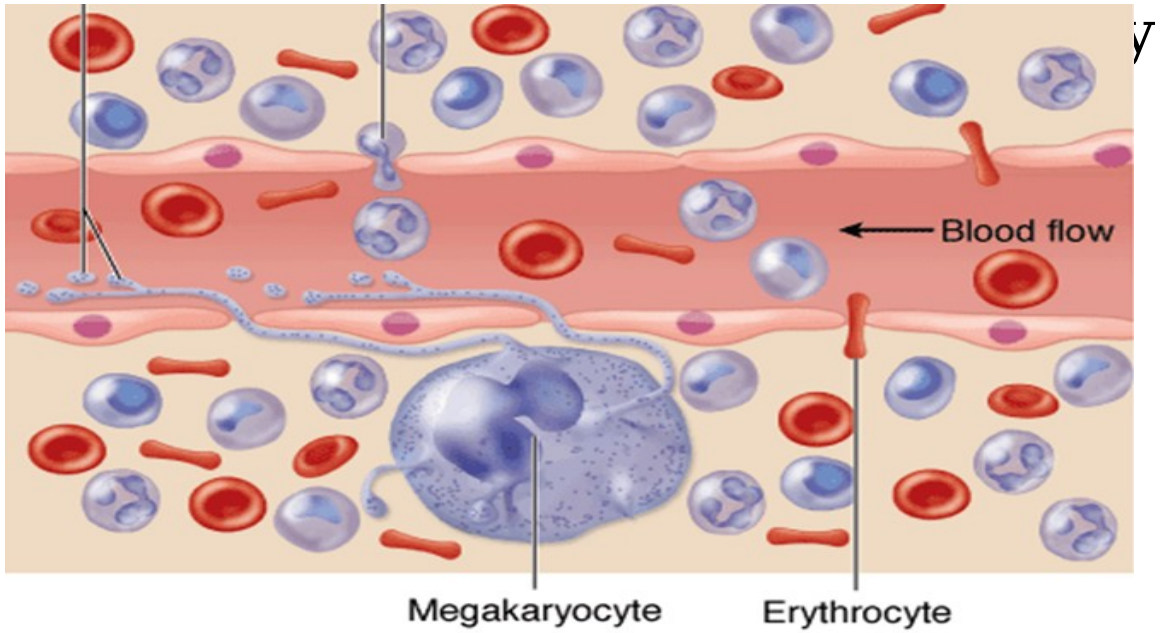
Megakaryocyte

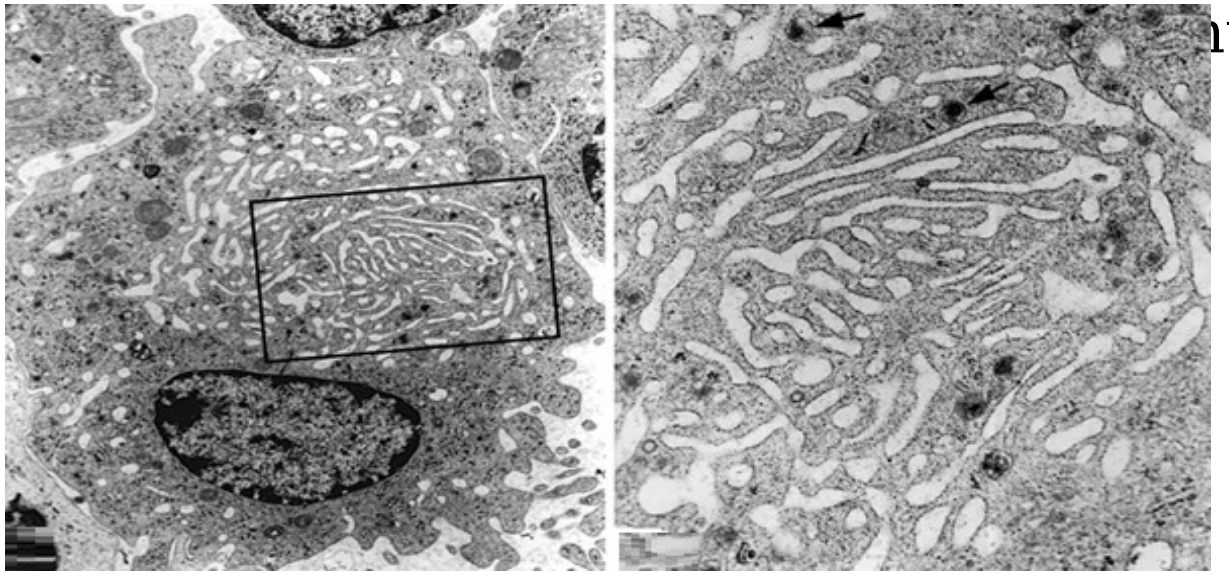
E.M: **- Mitochondria, well-developed rER, promi** **WHY??** **gi.**

- Branching processes (pro-platelets) penetrate adjacent blood sinusoi

to release platelets**.**

- "Demarcation channels" : numerous invaginations of plasma membra





https://mednexus.org/doi/full/10.1097/BS9.0000000000000093

Megakaryocyte

Fate:

Each megakaryocyte produces a few thousand platelets, then

it shows apoptotic changes , then

removed by macrophages.

Quiz

Which of the following is responsible for clot retraction ?and release reaction

A-Alpha granules
B-Delta granules
C-Lambda granules
D-Actin filaments
E- Microtubules

At site of vascular tears, platelets aggregate to form :plug with the help of

A- Alpha granules and microtubules
B- Delta granules and cell coat
C- Lambda granules and cell coat
D- Actin filaments and alpha granules
E- Microtubules and actin filaments

Lecture Quiz

In granulomere of platelets, the secretions which help in blood coagulation are found in

A-Alpha granules
B-Delta granules
C-Lambda granules
D-Hyalomere
E- Membranous channels

ADP and serotonin are found in platelets in

A- Alpha granules
B- Delta granules
C- Lambda granules
D- Dense tubular system

Quiz

A 5-year-old boy is brought to the physician by his father because of a 3-day history of recurrent nose-bleeds. He had a sore throat and a runny nose 3 weeks ago. His vital signs are within normal limits. There are multiple petechiae scattered over the trunk and back. Laboratory studies show a platelet count of 14,000/mm3. Which of the following of their content contain coagulation factors?

a- Alpha granules

b- Delta granules

c- Lambda granules

d- Hyalomere

Quiz

A 30-year-old woman comes to the physician because of bruising easily. She is currently taking no medications and has no significant past medical history. Laboratory studies are significant for a platelet count of 25,000/mm3 and the presence of high levels of antiplatelet antibodies. Which of the following features is most likely to be involved in platelet adhesion?

(A) Lambda granules
(B) Cell coat
(C) Microtubules
(D) Actin filaments
(E) Myosin filaments

Quiz

You are examining platelets in a blood film. What is the most characteristic feature to identify it?

A- it is biconcave in shape
B- It is double the size of RBCs
C- It has a central hyalomere
D- Its outer part is pale
E- Has a refractile granules in the periphery

Which of the following is a characteristic of the cell that

gives rise platelets?

a. Small cell circulating in the blood
b. Is multinucleated
c. Has polyploidy nucleus
d. Are rich in lysosomes

Quiz

A 35 year lady presented to the clinic with fatigue and on examination, there were peticheal hemorrhages on the lower limbs. Electron microscopic examination of the deficient structure shows its hyalomere rich in which of the following?

a- Clotting factors

b- Lysosomes

c- Coagulation factors

d- Microtubules

e- Mitochondria

Quiz

Give reasons:

- **Megakaryocytes have polyploid nucleus**
- **Clot retraction after platelet aggregation**

Correlate the structure of platelet granulomere to its role in controlling bleeding

-**Describe the steps involved in platelet formation**

Quiz

If your patient is on asprin (anti-platelets) and he is undergoing a surgery. When should he stop his asprin medication before his surgery? Why?

7-10 days before surgery to allow for new platelets synthesis that are not inhibited by asprin.

SUGGESTED TEXTBOOKS

1. Junqueira`s Basic Histology; Text and Atlas. 14th edition 2018.

2. Histology A Text and Atlas: Michael H. Ross and Wojciech Pawlina, 7th edition, 2016.

Thank you